Geology

Mountain Fire BAER
(San Bernardino NF)
August 1, 2013
Jerome V. DeGraff, Sierra NF

I. Resource Condition Assessment

Resource Setting – The Mountain fire burned 27,496 acres within the San Jacinto Mountains between San Jacinto Peak, on the north, and Garner Valley, on the south. The San Jacinto Mountains are the northernmost part of the northern Peninsular Range and form a high-standing massif with a succession of erosional surfaces forming benches and plateaus at lower levels (Matti and Morton, 2000). Garner Valley is the lowest of the erosional surfaces.

Like the Sierra Nevada, the San Jacinto Mountains consists of igneous granitic batholiths which intruded a mass of pre-existing sedimentary bedrock during the Mesozoic. Isolated Pleistocene to Recent deposits mantle erosional surfaces. Consequently, the bedrock underlying the area burned by the Mountain fire (in order of oldest to youngest) is: 1) metasedimentary (Paleozoic) bedrock including hornfels, schist, phyllites, gneiss, quartzite and marble, 2) granitic (Mesozoic) bedrock including granodiorites, tonalite and gabbro, and 3) Quaternary-aged fluvial deposits and alluvial valley deposits (Matti and Morton, 2000).

Debris flows and rockfalls are the primary geologic hazards associated with burned watersheds (Santi et al., 2013; Parise and Cannon, 2013). The methodology for assessing rockfall is largely dependent on professional geologic experience while assessing the likelihood of debris flows can draw upon empirical models developed from research in southern California and the Intermountain western United States (De Graff et al., 2007; Cannon et al., 2011; De Graff and Gallegos, 2012).

Findings of the On-The-Ground-Survey –Field survey within the watersheds from Fobes Canyon to Keenwild Fire Station was undertaken. A helicopter reconnaissance was another valuable source of information. For reference, this reconnaissance was recorded on a video. Field data was supplemented by GIS-generated data and observations from other resource specialists on the team.

Data on soil burn severity, the fire perimeter, and observations on the recent debris flow for this report are being used by the landslide hazards group of the U.S. Geological Survey (Golden, CO) to provide maps showing the probability of future occurrence. The 1.5 inches/hour rate of the July 21st storm was equivalent to the 5-year, 1-hour storm typical for this area. This reflects the importance of storm intensity to the triggering of debris flows which other research has previously shown (Cannon et al., 2008). The storm also illustrates that future debris flows can be triggered by storms that are relatively common to this area.

In addition to contributing to containment of the Mountain fire, the July 21, 2013 storm demonstrated that a debris flow hazard existed in the burned headwaters of Apple Canyon (Appendix A). The debris flow potential for this watershed was not diminished by this occurrence because burned watersheds on other fires in southern California and the Sierra Nevada have yielded multiple debris flows over 1 to 4 years following the fire (Wagner et al., 2013). The U.S. Geological Survey (Landslide Hazards Group) produced maps showing relative probability of a debris flow, range of debris flow volume, and combined probability/volume risk. The burned area was assessed based on delineation of fourteen (14) watersheds. Except for three watersheds in the vicinity of Mountain Center, CA, the watersheds encompassing National Forest System land are rated as having a moderate risk (within a range of low, moderate and high). Those watersheds draining to the east (non-NFS land) are rated as high risk.

Assessing rockfall hazard is location-specific to the value-at-risk. Because the hazard posed by individual or small clusters of rocks rolling downslope is common in mountainous area, postfire assessment needs to focus on the degree to which the burned conditions have increased the likelihood. These changes range from the loss of trees or other barriers to rock movement to greater movement of small granular particles which could destabilize the position of large rocks. Appendix B contains the field observations for rockfall hazard to State Highway 243 illustrating the application of the location-specific approach. The other locations where rockfall hazard was assessed included the residence (Abbot's house?) at eastern edge of Zen Center and the structure at western edge of Fobes Ranch. At the Abbot's house, the slope immediately adjacent does not appear to have had significant woody vegetation (trees or brush) prior to the fire. No significant rock outcrops or concentrations of boulders were seen. Therefore, the rockfall hazard to the Abbot's house appears unchanged from what existed prior to the fire. The structure at Fobes Ranch is below a steep slope which was burned. There is rock outcrops on the ridgeline but not directly upslope from the structure. Between the upper burned slope and the house is a dense stand of large trees and brush. The rockfall hazard to this structure at Fobes Ranch is considered to be unchanged by the fire because the vegetation buffer to rocks from the upper slopes remains present.

II. Emergency Determination

An emergency exists for both debris flow and rockfall hazard due to the Mountain fire. The risk is intermediate (combination of probability/volume translated into the BAER risk assessment matrix terminology) for all the watersheds defined as moderate by the U.S. Geological Survey modeling. The exceptions would be the Apple Creek drainage where the BAER risk is high to very high from its head to immediately downstream from Bonita Vista Ranch property and those watersheds rated as low would be defined as low risk under BAER.

An emergency exists for State Highway 243 north of Keenwild Fire Station for rockfall hazard from NFS land. While this is a possible event, the consequences are major making the BAER risk high.

III. Treatments to Mitigate the Emergency

Value-at-Risk	Objective	Description	Cost
1. State Highway 243 north of Keenwild Fire Station	Protect life and property	No effective NFS land treatment due to site conditions and low probability of occurance	**No cost to govt**.: make an official notification to the California Department of Transportation District responsible for this highway segment that rockfall is possible and their regulations may require signs or other actions.
2. Debris flow hazard to upper Apple Creek (Zen Center/Bonita Vista Ranch)	Protect life and property	No NFS land treatment; onsite actions would be effective	**No cost to govt**.: make notification of hazard to landowners; share risk information with NRCS, OES and other emergency service organizations; ensure NOAA coordination for storm warning notices; evaluate whether additional RAWS stations on NFS land might improve warning forecasts.

IV. Discussion/Summary/Recommendations

The table under III provides the recommendations to address debris flow and rockfall hazard. The U.S. Geological Survey (USGS) is revising their maps based on the field information. The volumes modeled will likely stay unchanged. However, the watershed delineations which are appropriate for the volume modeling appear to under-represent debris flow probability when analyzed by the probability model. Recognizing this issue is made possible by the existing postfire storm response. Therefore, the USGS is preparing probability for different segments of these watersheds. This will alter the risk maps but the change will only result in some parts remaining moderate and other parts increasing to high. While this could suggest other areas of the NFS land could generate debris flows, most would not require mitigation as there are significant no values-at-risk. Those watersheds where values-at-risk are identified (Apple Creek and Fobes Canyon) either have mitigation identified in this report or were evaluated for other resources with no mitigation possible.

V. References

Cannon, S.H., Boldt, E.M., Laber, J.L., Kean, J.W. and Staley, D.M. (2011) Rainfall intensity-duration thresholds for postfire debris-flow emergency-response planning. Natural Hazards 59:209-236.

De Graff, J.V., Cannon, S.H., Gartner, J.E. and Gallegos, A.J. (2007) Reducing post-wildfire debris flow risk through the burned area emergency response (BAER) process. In Schaefer, V.

De Graff, J. V. and Gallegos, A. J. (2012) The Challenge of Improving Identification of Rockfall Hazard after Wildfires: Environmental and Engineering Geoscience 18(4):389-397

Matti, J. C. and Morton, D. M. (2000) Geology of the San Bernardino National Forest. Unpublished U.S. Geological Survey manuscript, http://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5207093.pdf.

Parise, M. and Cannon, S.H. (2012) Wildfire impacts on the processes that generate debris flows in burned watersheds. Natural Hazards 61:217-227.

Santi, P., Cannon, S., De Graff, J. (2013) Wildfire and landscape change, In Shroder, J. (Editor in Chief), James, L.A., Harden, C.P., Clague, J.J. (eds.), Treatise on Geomorphology. Academic Press, San Diego, CA, Vol. 13, Geomorphology of Human Disturbances, Climate Change, and Natural Hazards, pp. 262–287.

Wagner, D. .L., De Graff, J. V. and Lancaster, J. T. (2013) Debris flows in the southern and eastern Sierra Nevada region, California, In Putirka, K. (ed.) Geologic Excursions from Fresno, California, and the Central Valley: A Tour of California's Iconic Geology: Geological Society of America Field Guide 32, p. 99–128, doi:10.1130/2013.0032(06).

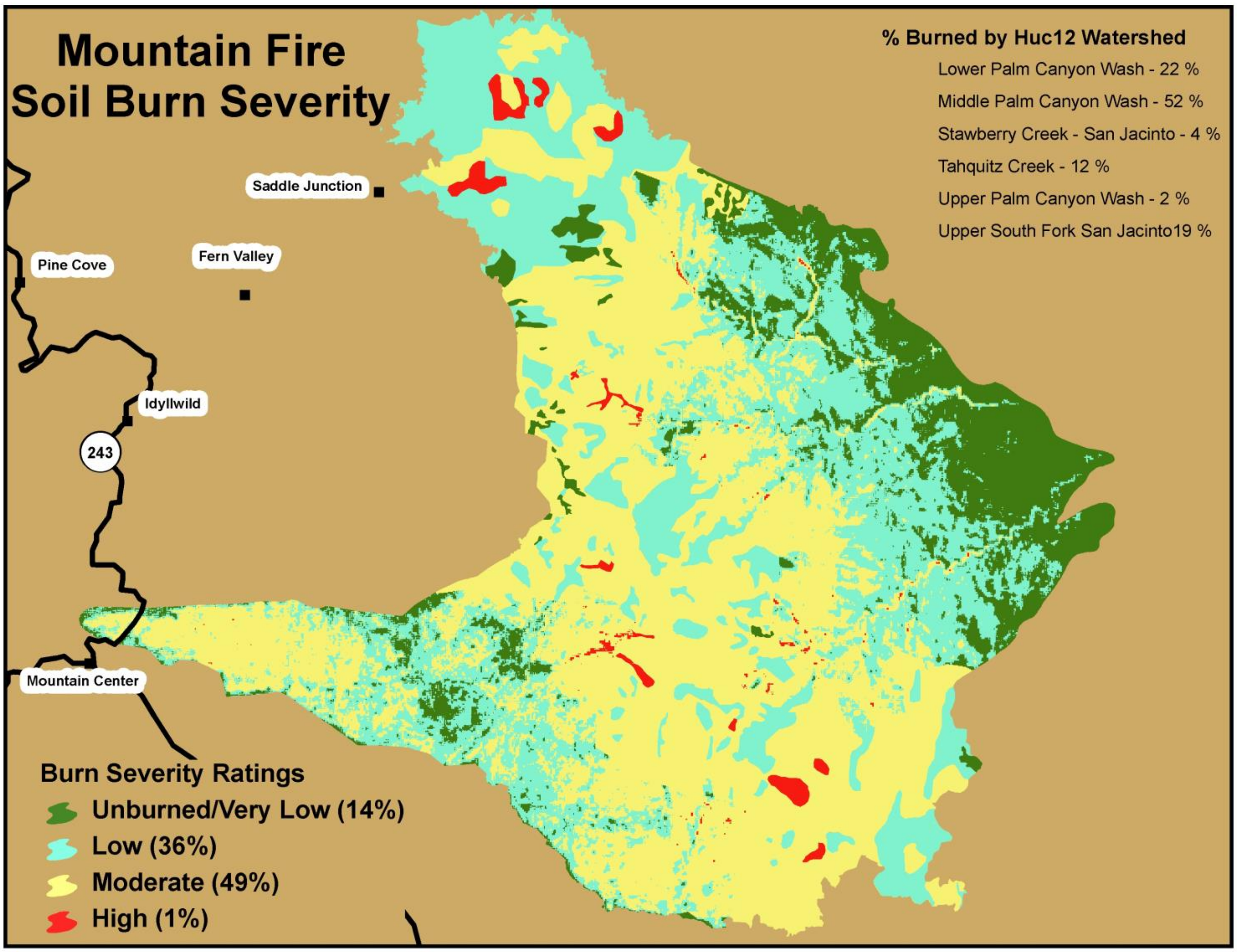

Figure 1. Map showing the soil burn severity map for the entire Mountain fire area. The location of some communities and State Highway 243 are shown for location context.

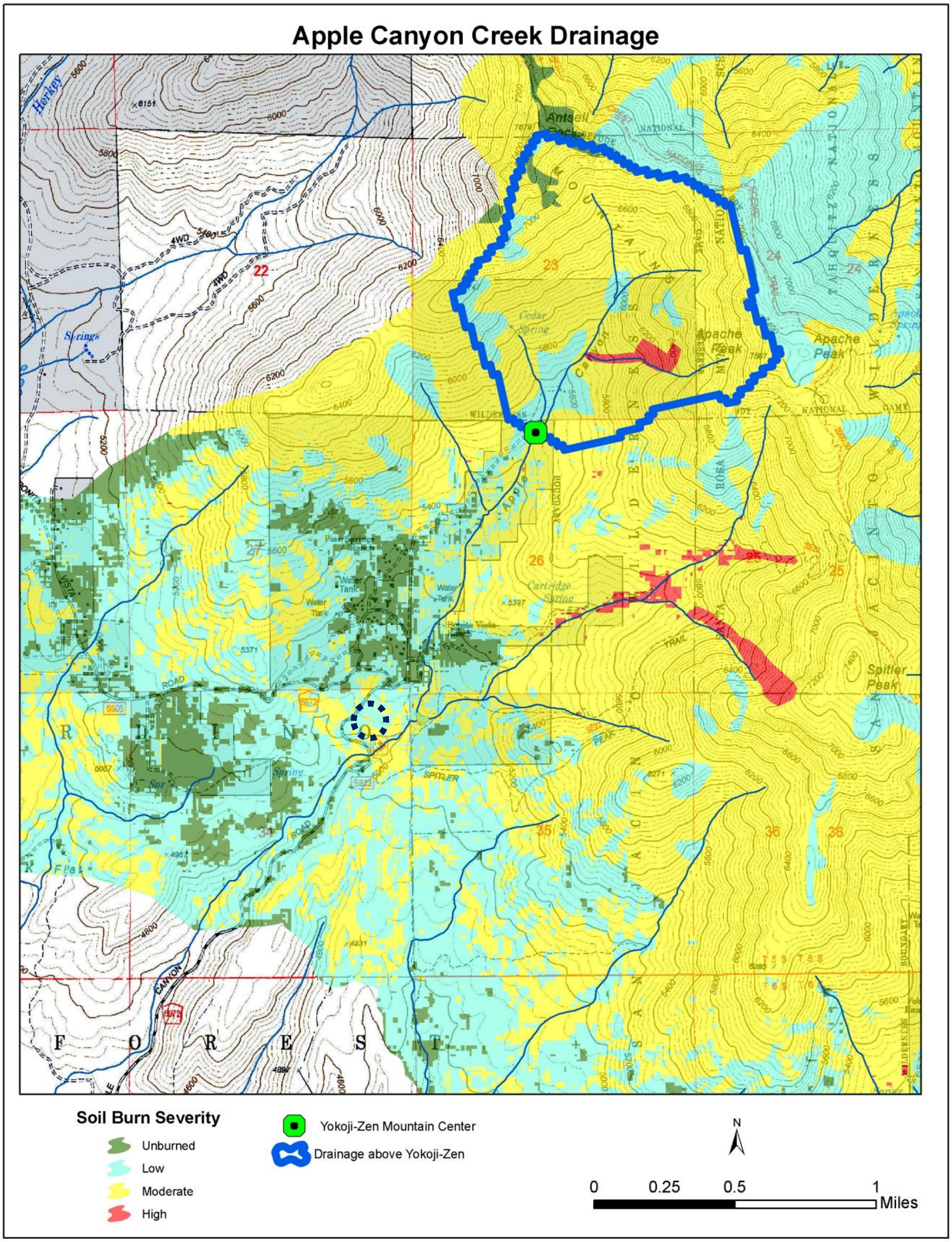

Figure 1. Map showing the soil burn severity within the upper Apple Creek drainage due to the Mountain fire. The 537-acre watershed which impacts the Yokoji-Zen Mountain Center is outlined in blue. The black dashed circle shows a pond which is not filled with sediment washed down from the severely burned areas upstream during the July 21st storm. Field evidence suggests this was a hyperconcentrated flood flow rather than a debris flow.

APPENDIX A

Observations of the Effects of the July 21st Storm in Apple Canyon

Observations at head of Apple Canyon (Apple Creek) and Fobes Canyon

On Monday, July 22, 2013, a convective storm occurred over the Mountain Fire in the San Jacinto Mountains. A flash flood warning was issued by the National Weather Service shortly before noon. The storm was short but intense.

> The Mountain Fire started at 1:43 PM on July 15, 2013 near the junction of Highway 243 and Highway 74. It burned east of Mountain Center, through the Apple Canyon and Bonita Vista areas, and then along the Desert Divide and southern portion of the San Jacinto Wilderness. Since the fire started several rain events have occurred. The first rain event dropped 0.02 inches and occurred on July 20. The second rain event was measured at the Mt. San Jacinto Raws station near the north end of the fire. This rain event occurred on July 21 and dropped approximately 2.36 inches, of which over 1.5 inches fell between 3 and 4 am. The same rain event dropped 1.03 inches near the southeastern edge of the fire as was measured at the Keenwild Raws station. Most of the 1.03 inches fell between 12pm and 2 pm. This seems to indicate that the northern portion of the fire may have seen more rainfall and of higher intensity. Then on July 22 0.2 inches fell on the fire. On July 25 0.04 inches of rain fell on the fire. Finally, on July 26 0.03 inches of rain fell on the fire.
> -**Nathan Sill, Aquatic Biologist, Mountain BAER team**

The July 21, 2013 storm intensity is effectively a 5-year, 1 hour storm event for this area (W. Wells, Mountain BAER hydrologist, pers. comm., 2013). The storm dramatically reduced fire expansion and contributed to its full containment a few days later. It also caused a debris flow and flooding in Apple Canyon (Apple Creek) and flooding in Fobes Canyon. Both are south-flowing streams draining the southwestern part of the burned area. Apple Canyon and Fobes Canyon are subparallel to each other and about two miles apart. The canyons both head in the same ridge of the San Jacinto Mountains. Spittler Peak is the highest point on the ridge between them. The drainages from both Apple Canyon and Fobes Canyon flow into the Garner Valley area.

The Apple Canyon debris flow initiated in the headwaters of Apple Creek impacting the nearby Yokoji-Zen Mountain Center (hereafter referred to as "the Center") (http://zmc.org/?gclid=CPCF07ae0LgCFcaDQgoddQkAMQ) (Figs. 1and 2). During our initial field review on Friday, July 26, 2013, we found the personnel at the Center continuing cleanup using a small tractor and hand tools. We spoke with [redacted] who is the Roshi (Abbot) for the Center. He related how they had been clearing the debris for several days. They recognize the potential for a repeat of this event and have developed an evacuation plan for staff and visitors. It is their intent to alter the stream channel to an existing lower part of the floodplain and place structures (earthen?) to protect existing buildings. The cleanup made it difficult to assess the total volume deposited within the ground.

Mr. [redacted] stated that eighteen (18) inches of mud had filled the garage attached to one of the buildings next to the stream (Fig. 3). Some undisturbed deposit was present despite the extensive cleanup efforts (Fig. 4). Most of the onsite impact resulted from the large debris flow which entered the Center from the upstream part of Apple Creek. The material spread over the Center grounds on the existing valley fill. In addition to running out downstream from the Center, a part of the flow passed beyond the parking area onto the native-surfaced road. This material effectively blocked access down Apple Canyon road. Re-opening the road required excavation by Riverside County public works to enable cars to evacuate people from the Center.

The debris flow in Apple Creek immediately upstream from the Center flowed over a 60-foot wide channel (Fig. 5). Several hundred feet upstream from the center, a tributary headed on the ridge to the east, contributed a debris flow to the one moving through the main channel. The tributary channel is scoured to bedrock through the lower few hundred feet (Fig. 6). The gradient is estimated to be ~60%. The survey continued up Apple Creek and observed discontinuous levees and other evidence of the debris flow's passage (Fig. 7). The channel becomes more confined and narrows to about 10 to 15 feet wide. While the gradient increased along this channel, it was only about 20% at the steeper, upper end. Along the upper end of the surveyed channel, a number of locations on both sides of the channel had rills originating on the slopes above the channel. For the last few hundred feet, evidence of the event being a debris flow was absent. The extent of the flow event was still visible by the muddy deposits delineating the margins and occasional mud splashes on the upstream sides of large vertical trees adjacent to the channel. The field survey was terminated due to the urgency of other site survey needs.

On the walk back down the channel to the Center, a small debris flow was seen entering the main channel from the west side (Fig. 8). The small debris flow was composed of finer-grained material with prominent levees. Following the debris flow upslope, it appeared to pass along a pre-existing footpath from a residential building. The debris flow had deposited on the step at the residence's doorway after having flowed down a steep slope below the access road to the Center's water wells. The debris flow had impacted and passed around another small structure just below the road before reaching the residence (Fig. 9). From the road, it was clear the debris flow originated from rilling on a steep burned slope upslope from the road. When the flow reached the road, it continued on the road surface for a short distance (few tens of feet) before passing onto the slope where the structures are located. Sandbags were placed along the outer edge of the road to block any future debris flow movement along this track to those structures. However, it will mean any future flow intersected by the road will continue down the road toward the Center's parking area. A helicopter overflight of the Mountain Fire took place on July 27, 2013. Photos show the extensive rilling visible on the slopes at the head of Apple Canyon (Fig. 10).

It should be noted that downstream from Yokoji-Zen Mountain Center, there are other structures and infrastructure on private land within the San Bernardino National Forest. This is on the broad alluvial fill associated with Apple Creek. At the upper end of the private land is the Spring Ranch. During the storm, Forest service personnel were present. A flow of muddy water from Apple Creek displaced the water in a pond which is about 15-feet deep leaving it filled with mud in the storm's aftermath. Above this location, the channel appears to have carried a hyperconcentrated flow or very muddy flood waters in the aftermath of the debris flow at the Center.

At the lower end of the private land parcel, which includes Spring Ranch and Bonita Vista Ranch, A major tributary to Apple Creek connects from the vicinity of Cartridge Spring and the adjacent slopes between Apache and Spittler peaks. The area along the upper part of this tributary burned at high and moderate burn severity not unlike the conditions above the Yokoji-Zen Mountain Center. A water impoundment is located just before the tributary joins the main channel. Like at Spring Ranch, this pond was completely filled with sediment to the full height of the small dam (Fig. 11). Evidence along the channel upstream from the pond as far as the Cartridge Springs area, the material deposited in the pond was due to flooding. Debris flow levees and similar features were absent (Fig. 12). It is possible the event was actually a hyperconcentrated flow.

A watershed response to the storm was observed for Fobes Ranch in Fobes Canyon. While the flooding impacted some parts of Fobes Ranch near the head of the canyon and the road downstream, it was clearly water with a high concentration of sediment and ash. Limited damage was caused by this flooding. Figure 13 shows the location of the ranch within the head of the canyon. Evidence of a sustained muddy water flow within the channel was seen as far downstream at the fire perimeter. A t one point within one-quarter mile of the ranch buildings, deposits on the road from nearby rilled slopes were observed to join with the main channel. Only evidence of muddy water was seen during a survey within the ranch (Fig. 14). The owners indicate that water flooding is commonly experienced within the ranch grounds during seasonal storms. No damage was sustained by the ranch structures and facilities clustered in the flat during this most recent storm event. Only muddy sediment was seen along the drainages through the ranch area. The flow that was observed in the channel downstream is from the main drainage which passes just to the east of the ranch buildings (Fig. 15).

Both the heads of Apple Canyon and Fobes Canyon were subjected to both high and moderate soil burn severity. However, the head of Apple Canyon experienced a significant debris flow while the tributary near Cartridge Springs and Fobes Canyon experiences only flooding with significant sediment. While differences in the localized storm intensity cannot be ruled out, it seems most likely a consequence of differences in slope steepness and bedrock influence on the underlying soils. The slopes around Apple Canyon appear to casual observation to be steeper than those at the head of the Cartridge Springs tributary and Fobes Canyon. However, no specific analysis was made to verify or quantify what difference may exist as that is beyond the requirements of this BAER assessment. Another obvious difference between these two locations is bedrock lithology which would affect the soil developed on these slopes. Fobes Canyon is developed in Paleozoic metasedimentary bedrock while Apple Canyon is within undifferentiated tonalite and granodiorites. This suggests that tonalte and granodiorite bedrock may be more prone to development of debris flows.

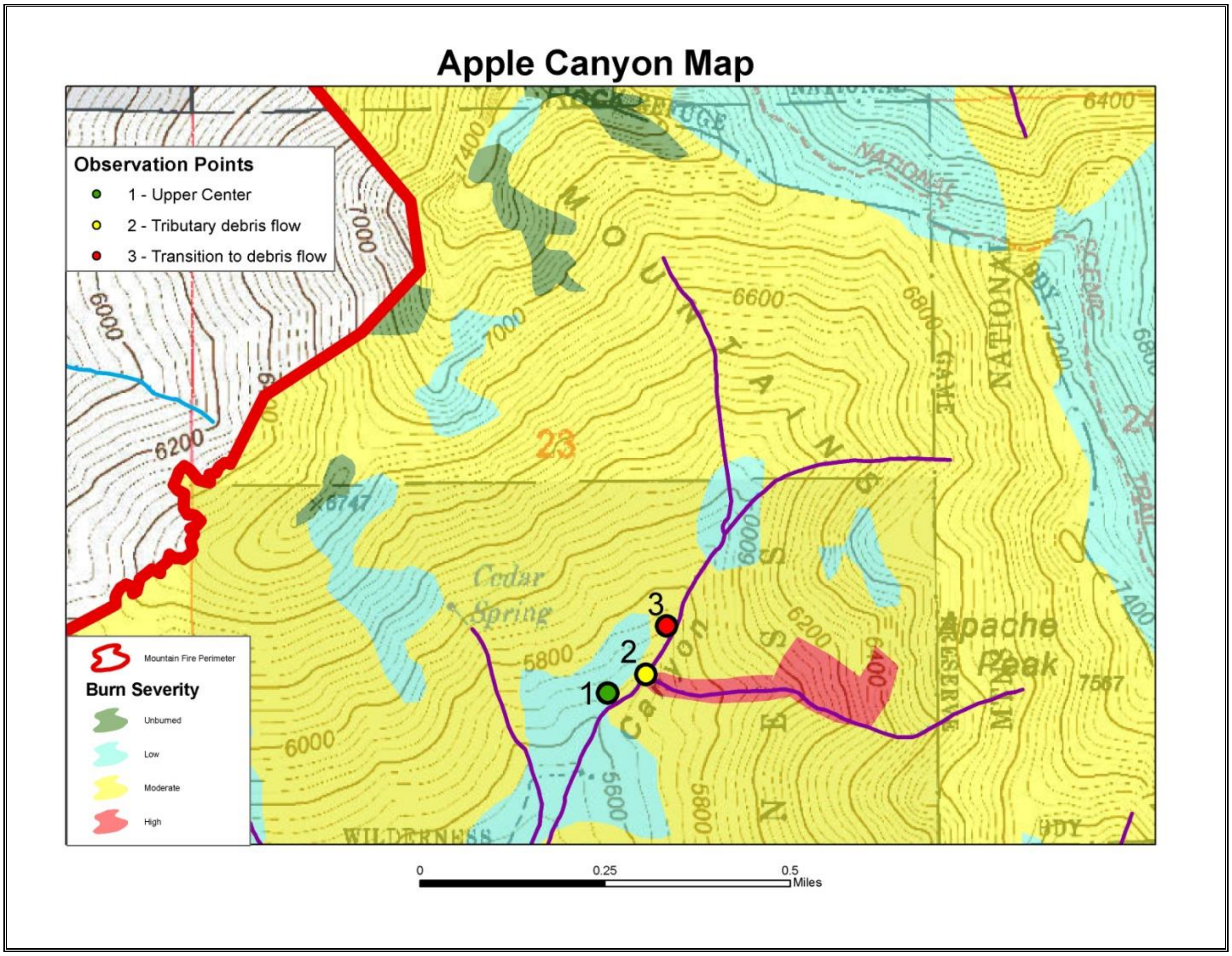

Figure 1. Map of the watershed which was the source of the debris flow impacting the Yokoji-Zen Mountain Center. The point locations (1-3) are referred to in the text.

Figure 2. The Yokoji-Zen Mountain Center at the head of Apple Canyon. The Abbot's house is visible to the right (east) of the Center's buildings in the area of unburned trees.

Figure 3. Looking downstream along the channel of Apple Creek within the Yokoji-Zen Mountain Center in Apple Canyon. Apple Creek is visible in the small channel just past the boulder deposit. The white building in the left background is the administrative office. The garage (with open door) where deposition occurred is visible to the right and farther downstream relative to the office.

Figure 4. Within the Center grounds, the debris flows deposited across the surface of an alluvial fill. This shows material within an area of the Center grounds which is topographically lower than the present channel. This photo was taken at about 33.71828200/-116.63960800.

Figure 5. A view of the 60-foot wide impacted channel upstream from the Center. The debris flow passed from right to left. Part of a levee is visible in the foreground. A tributary debris flow entered behind and to the left of the individual taking this photo and contributed some of the material seen in the left foreground. The GPS coordinates for this location are: 33.71864800/-116.63870200.

Figure 6. A view looking up the steep channel which was the source for the tributary debris flow entering the main channel at the location noted in Figure 6.

Figure 7. A view of the channel at the farthest point upstream from the Center where evidence of debris flow passage (discontinuous levees, matrix-supported large rock) was found. The GPS coordinates for this location are: 33.71959800/-116.63821000. Along the channel for several hundreds of feet upstream from this point only showed evidence of hyperconcentrated flow passage.

Figure 8. The lower part of the small debris flow near where it entered the main channel. This is looking upslope to the residence structure seen in Figure 8.

Figure 9. A small debris flow diverted by a minor access road passed downslope to impact this small structure and the porch of the residence below. This photo was taken from the edge of the road.

Figure 10. Some of the rilling visible on the slope above Apple Creek as seen from a helicopter overflight. This area drains into the upper part of the channel surveyed upstream from the Center. This is representative of rilling on steep slopes within the head of Apple Canyon.

Figure 11. The sediment-filled impoundment on the tributary to Apple Creek resulting from the July 21, 2013 storm event.

Figure 12. Deposition along the tributary to Apple Creek from the passage of the sediment-laden water.

Figure 13. Fobes Ranch (scorched trees and buildings in right foreground) near the head of Fobes Canyon. A large patch of unburned (green) is associated with a major spring.

Figure 14. Muddy deposits from water flow through the Fobes Ranch. This view is towards downstream direction.

Figure 15. A photo to the northwest across the Fobes Ranch (left foreground). The trees passing from the lower left corner to the right of this view is the main stream channel. Notice the absence of visible rilling on the the slopes at the head of Fobes Canyon in this photo and in figure 10.

APPENDIX B

Evaluation of Rockfall Hazard to Highway 243

Field Evaluation of Rockfall Hazard to State Highway 243

Problem: Near Keenwild Fire Station, State Highway 243 between Idyllwild and Mountain Center passes through a corner of the Mountain Fire perimeter. A burned area of concern is the slope above Highway 243 just north of Keenwild Fire Station (Fig. 1). The burned slope of concern is bounded on the west by Highway 243, north by the fire perimeter, on the south by a line extending east from the junction of State Highway 243 and Forest Road 5S01 (the road into Keenwild Fire Station), and on the east by Forest Road 5S01 where it passes along the top of the slope on the way to Keenwild Helibase.

The slope is underlain by granitic bedrock which exhibits typical exfoliation and vertical jointing. A variety of individual granitic boulders are visible on the slope. Rock outcrops are present. The soil burn severity is low on the northern and southern edges of the area of concern. It is moderate across the remainder of the area.

The area of concern can be divided into three slope units with differing rockfall risk potential. The first area is the northernmost moderately burned area extending to Highway 243 from the junction of Forest Road 5S01 and a trail on the former 5S03 road bed (Fig. 2). This is a planar slope with rock outcrops at the top and large to medium-sized boulders scattered down the slope. A few burned bushes are present, too. The slope averages 45% to the road. The cutslope at the toe averages 6 feet in height at an estimated 80% to the road shoulder. No rocks or dry ravel were present to suggest that rocks have moved down the slope to the road.

The second and largest part of the area is characterized by two steep-sided and deeply incised swales. Rocks are scattered on the swale slopes. The swales end at a snorkel inlet to the culvert draining this area (Fig. 3). The swale bottoms grade to an average of 45%. There is a 15 by 6-foot basin around the inlet with the long dimension being parallel to the road alignment. The basin side closest to the road is 6-foot deep and nearly vertical. Dry ravel and displaced rocks were not seen in this basin to suggest movement of rocks had occurred since the fire paced through.

The third part of the area is the on the south. It is a relatively flat slope from Forest Road 5S01 to near Highway 243. The end of the flat ends with exposed jointed, granitic bedrock. From the top of the bedrock to the road shoulder is about 10-feet high and inclined nearly vertically (Fig. 4). Some dry ravel (a thin layer over ash-covered soil) and a few rocks up to 3-inches in diameter are present suggesting some movement of material down the steep face (Fig. 5). This high cutslope grades to a minor cutslope with some scattered rock on a 20% slope which ends at the driveway to Keenwild Fire Station (and its mailbox).

Usually, rock movement and dry ravel occur as the fire passes over the area and shortly afterwards. The absence of this evidence of movement adjacent to Highway 243 suggests little rockfall has occurred. This may change during future storm events. The movement of individual rocks into the road bed is the most likely rockfall event in the future. While this seems a low likelihood event, given the evidence to date, it only takes a single rock being unexpectedly struck by a motorist or motorcyclist failing to see it in time.

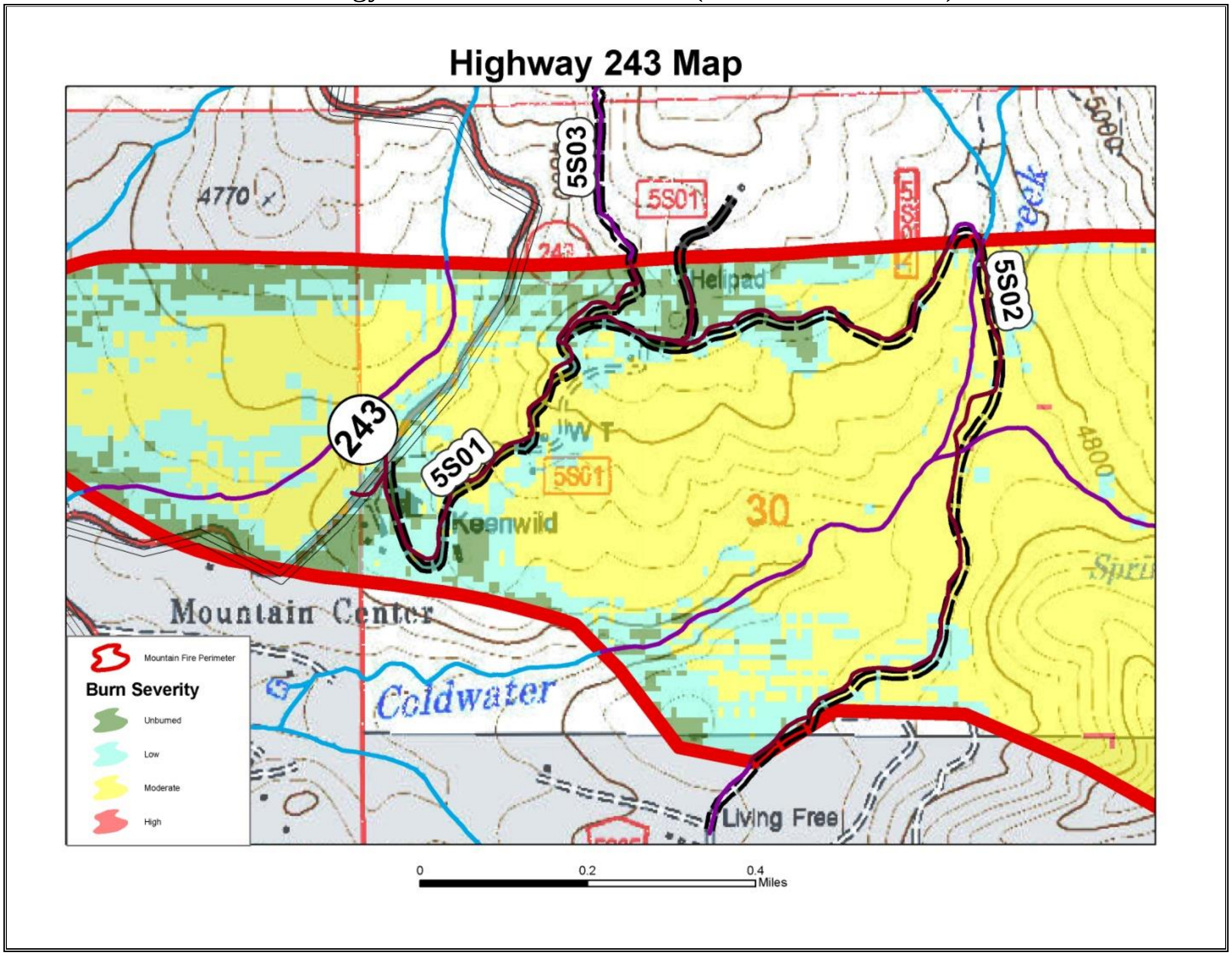

Figure 1. Location of burned slope between Highway 243 and Forest road 5S01 near Keenwild Fire Station and Helibase evaluated for rockfall hazard.

Figure 2. View down slope along the northern planar section. Highway 243 is just barely visible just left of center in the background.

Figure 3. The large area in the middle of the moderately burned slope. Highway 243 is seen along the right-hand side of this view. Note the vertical snorkel pipe at the toe of the swale.

Figure 4 The third segment of slope evaluated showing the steep cutslope with exposed bedrock.

Figure 5. Minor dry ravel and small rocks at base of rock outcrop in cutslope along Highway 243.